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TECHNICAL OPERATIONS COMMITTEE

A New Line of Low-Cost Light-Duty Teletypewriter Equipment

N. A. JACOBS

Summary: A new line of teletypewriter equipment, the Model 32/33 station sets, has been developed specifically to meet the needs of light-duty applications. Achieving low cost through design, manufacturing techniques, and limits on versatility and service life, these attractively styled machines are a valuable addition to the printed communications industry.

THE PRINTED communications market can be arbitrarily divided into two categories of users: the customer who has an elaborate system which demands rugged equipment running continuously for extended periods of time without maintenance, and the customer who requires the same type of equipment but only for periods of up to 2 hours per day. Since standard printing telegraph apparatus was primarily designed for the heavy-duty user, the customer in the second category found himself at a considerable economic disadvantage, primarily because of the higher initial cost of heavy-duty equipment. A review of machines used in the light-duty category reveals that many have been in service for 30 years and have not nearly expended their available life.

Economic studies computing the overall average yearly cost for both the heavy-duty and light-duty types of machines have indicated that there would be a break-even usage point of 3 to 5 hours per day. The studies assumed the presence of a large system of about 100,000 stations and were based upon test data relating to service life and anticipated maintenance; taken into account were initial cost, replacement cost, rebuilding costs, service life, maintenance costs, and obsolescence factors. These studies are not conclusive, however, and actual service may eventually produce quite different results.

A design and development program was inaugurated, based on the concept of making available to a commercial market a line of record communications equip-

ment which would make economic sense for users over service periods of 5 minutes to 2 hours per day. This would not only provide a better basis for the current light-duty users of such equipment, but also open markets to others.

One of the factors which influenced the design of the light-duty line of equipment was the advent of data processing. With the rapid rise in the use of computers, business machines, and other specialized data equipment, machines talking to machines has become a large-scale business. From the start, capacity for accepting 8-level codes was designed into the machine. This allows economic data transmission, using the new American Standards Association data interchange code, from a multiplicity of light-duty sources into a central data processor.

Another influencing factor was styling, since it was desirable to have a machine which would be compatible in appearance and color with modern office decors. Throughout the development period, close co-ordination with an industrial design firm was undertaken to achieve this objective. (See Fig. 1.)

Estimates of initial cost, service life, maintenance expense, and obsolescence must all be considered. Overdesign can be as costly as underdesign. In a unit which is intended for light duty, service life becomes most significant. There is no need to use the best or most durable material (expensive) throughout the unit in an effort to make it last long beyond obsolescence. Certainly there are areas where durability is required; during the anticipated service life of the unit, some 6,000,000 words would be printed, with various mechanisms undergoing 36,000,000 cycles of operation. However, during the same period of time, other mechanisms, owing to their mechanical nature and usage, would undergo far fewer operations. The line-feed mechanism, for example, would undergo approximately 1,000,000 operations; the ribbon reversing mechanism, only 6,000 operations; the platen itself, 50,000 revolutions; the automatic-answering mechanism, 240,000 operations, etc. Also, in a transmitting-receiving device of this sort, the keyboard is used only about one-half as much as the typing unit is used.

The target, then, was to design a machine which would provide dependable operation for a specific length of time. The restricted service life concept allowed significant economic savings to be designed into the equipment; maximum savings, of course, can only be realized through high volume production.

How Low Cost Was Achieved

In the execution of the Model 32/33 station sets, low cost was achieved in the following ways:

1. The mechanisms were simplified.
2. Plastic and other low-cost engineering materials and methods were used.
3. Hardening and straightening were eliminated.
4. Assembly was simplified.
5. The versatility of the machine was limited.

First, the mechanism was simplified to the highest possible degree; this was achieved by making one part do the job of many, wherever possible. As an example of this, a small molded plastic part in the keyboard combines spacers, pivots, arms, guides, and functional contours into a single piece, which costs less than one-tenth of what it would cost to do the same job with individual metal parts.

Throughout the machine, numerous die castings, plastic moldings, and sintered metal parts are used. The main frame of the printer, for example, is one large

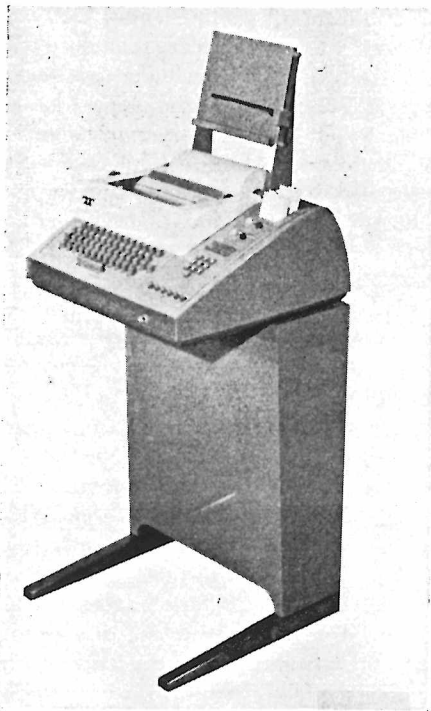


Fig. 1. Model 33A3 teletypewriter

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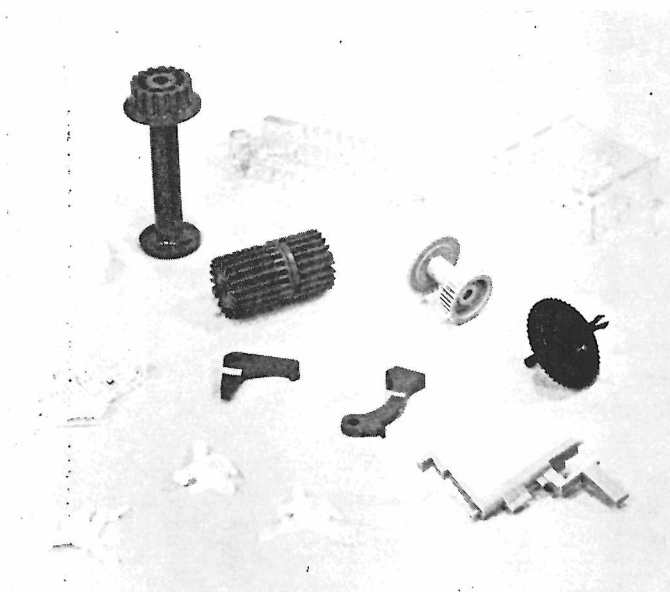


Fig. 2. Molded plastic parts used in M33 equipment

die casting which, while being very complex, has been specifically designed so that there is no side coring or special machining necessary after the part comes out of the die. Load studies were made in all cases, and it was determined that the material chosen to do a particular job would last long enough to satisfy the service requirements of the machine (see Figs. 2 and 3).

In order to obtain durability in a heavy-duty machine, many parts usually have to be hardened. These parts are normally bent, twisted, and bowed when they come from the hardening room. To get them back into a usable form, a worker beats on them with a hammer until they meet the print requirements; this, obviously, is a very expensive procedure. A great advance was made on the Model 32/33 station sets by the elimination or reduction of hardening wherever possible. Again, load studies and calculation of the number of operations a mechanism would undergo entered into the decision of whether a part should be hardened. It was found that many parts could be dead soft; where hardness is required, extensive use is made of local hardening techniques, in which only a very small portion of a particular part is hardened. In this way, distortions introduced by hardening are held to a minimum, and hand straightening is not required. Other parts which require only partial hardening are blanked directly out of spring tempered stock.

The assembly of the machines has been simplified by several techniques. First, on the main die-cast frame of the machine, all the screws, which are of a "self-tapping" nature, are driven in. All the other subassemblies can be placed on the machine merely by slipping them under

the heads of the screws and giving the screws a last turn or two for final tightening. Another technique can be found on the keyboard where the entire assembly is put together without the use of a single screw or nut; extensive use is made of "snap-together" assemblies and snap-ring retainers.

Limited versatility is best illustrated by the fact that the machine will not be capable of horizontal and vertical tabulations. This actually made the design of the machine easier as it was not necessary to worry about leaving space for such mechanisms.

Operation

The electric signals from a teletypewriter consist of a series of d-c pulses. A pulse where there is current is known as a "marking" pulse, while a pulse where there is no current is known as a "spacing" pulse. The signal always consists of a "start" pulse, which is spacing, followed by five to eight information pulses (depending upon the communication system),

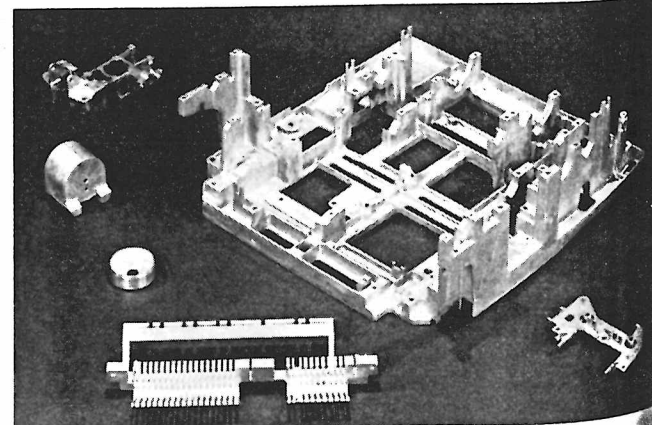
and followed by a "stop" pulse, always marking. The "idle" line condition is always marking (see Fig. 4).

The signal is generated in the 32/33 station set from the keyboard by means of parallel action code bars. The depression of the keylever positions the entire series of code bars, two code bars for every information pulse. Although, on the surface, two code bars would appear to be more expensive, this is actually not so because of their very low design cost (other advantages include better "touch"). As one code bar goes down, the other code bar goes up. The net output of this action is to close a contact and there is one contact closure for every code pulse. This results in parallel wire information, which is fed to a printed-circuit commutator type of distributor disk. The depression of a keylever also trips the distributor clutch. As the clutch rotates, a brush picks up the signal as set up by the keyboard contacts and, thus, converts the parallel wire output to the sequential pulse output (see Fig. 5).

This sequential pulse output is fed to the selector magnet, which attracts an armature. The armature will respond to the electrical signal in the same fashion as a relay. On the receipt of a start pulse, the armature drops away from the magnet; this action is mechanically sensed in order to start the selector clutch. As the armature undergoes further operations for the information pulses, it is mechanically sensed by levers, and the final result is a parallel mechanical motion output. At the proper point in the selector cycle, a cam trips the code-bar clutch, which allows the printer code bars to move diagonally upwards in order to transfer the information stored in the selector into the printer itself.

At a predetermined time, the code-bar clutch trips the function clutch, which provides motion and power for the printing mechanism for sensing and actuating special functions. The upwards com-

Fig. 3. Die-cast metal parts used in M33 equipment



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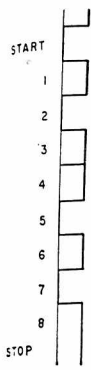


Fig. 4 (left). Teleprinter signal (8-level code)

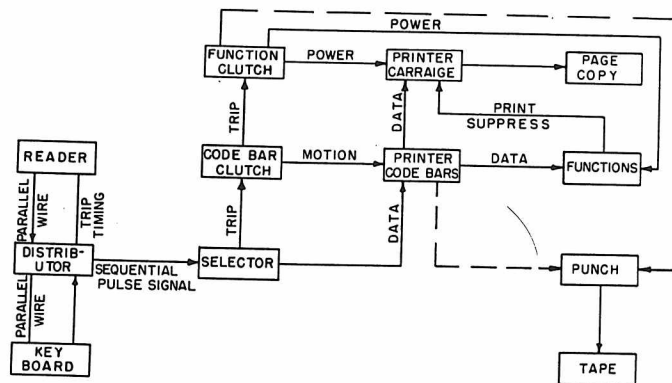


Fig. 5 (right). Block diagram of printer operation

ponent of travel of the printer code bars gives information to the printing carriage; the sideways component of code-bar motion gives information for sensing functions.

The 32/33 station set prints by means of a typewheel; i.e., all of the characters to be selected are wrapped around a cylindrical wheel. The cylinder has 16 peripheral positions and 4 vertical positions, giving 64 possible printed combinations. With the function clutch giving motion and power and the code bars giving information to the carriage, the typewheel is positioned vertically and rotationally through the use of permissive mechanisms. A permissive mechanism is one in which, the mechanism may be stopped at any point within a total given amount of travel, while the remainder of the motion is used to stretch a spring.

The bottom of the code bars are coded so that function levers underneath them may continually sense, searching for a particular combination of pulses. When such a combination occurs, the function lever is allowed to act and perform the function for which it was designed.

Additional Equipment

The preceding description covers the basic send-receive page printer. By using the same concepts of light duty and low-cost service, a perforator and reader have been developed. The purpose of the perforator is to produce a punched tape for later transmittal or retransmittal of the message stored in it; the reader is the transmitting device for the tape.

It is interesting to note that both of these are slave mechanisms. Neither can operate by itself; instead both use mechanisms already in the machine to provide power and information. This is another example of limited versatility, since most similar machines are capable of receiving page copy while the operator is independently punching a tape from the keyboard. The price for such independence is, of course, the need for redundant mechanisms.

Controls

Under the cover, to the right of the mechanisms, is an area which is reserved for electric and electronic controls. The actual form that these controls will take depends upon the system and varies widely in practice. However, one portion of these controls, known as the selector magnet driver, is constant.

The standard teletypewriter signal has traditionally consisted of a 60-ma (milli-ampere) current at approximately 120 volts d-c. The transmission of this type of signal is normally distorted because of line and magnet inductance. The design of the selector magnet coil is very difficult under these conditions, since the entire assembly must be extremely sensitive. Because of the line distortion induced in transmission, most users installed a line relay which shaped up the leading and trailing edges of the d-c signal pulses. On this project, all machines include a low-cost electronic package which allows the use of a much less sensitive (and costly) magnet assembly. This package is, in effect, a d-c amplifier. It takes an

incoming signal of any ordinary current value and amplifies it to 500 ma, the current at which the Model 32/33 station sets' selector magnets operate. This accomplishes two more things: it produces a purely resistive load to the teletypewriter transmission line, thus reducing effective distortion, and it permits operation from low-voltage sources, such as the output of demodulator and data sets.

Many systems now being employed transmit from station to station by tones. The data set used for this purpose may be placed in the pedestal upon which the machine is mounted. Inputs to and outputs from the data set are the d-c signals normally supplied by the transmitting distributor and applied to the selector magnet driver. Control buttons, dialing devices, alarm lights, etc., normally necessary for the proper operation of data set equipment or associated with system operation, may be located in the area at the right side of the machine.

Conclusion

The Model 32/33 station sets have been designed for a specific service life application to fill a specific economic need. The machines use the latest advances in the technology of the die-casting and plastics field; this, in combination with good mechanical design, has greatly reduced the cost of the apparatus, as compared to standard teletypewriters. Provisions have been made under the cover and within the stand of the machine to accommodate the electric and electronic controls necessary for most system applications.

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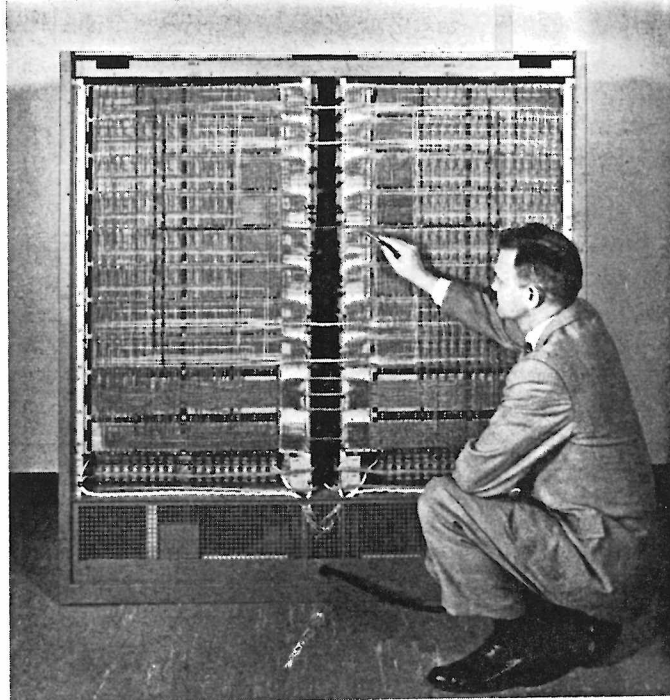
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Wiring

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between units is provided by local cables positioned in a vertical channel in the center of the cabinet. The cables connect to the equipment units by means of terminal blocks at the end of each tray. The cables reach the swing-out units by means of flexible cable arms which loop around the hinge and onto the terminal block. The cable arms are designed to withstand in excess of 2,400 operations without wire breakage. The two transmission buses which carry the time division connection are located on the trays of the rear bays. Within each tray, the buses are shielded from each other by a copper ground plane which is perforated to allow the wire wrap terminals to protrude through. Between trays, the talking buses are connected by means of a coaxial cable. Fusing to protect the wiring and eliminate fire hazards is organized so that a single blown fuse will not totally disrupt service.

The switch unit is designed to minimize installation time. The small size of the unit permits movement through standard doors, hallways, and elevators. Wiring of the four stub-ended cables into the customer's cross-connection box and provision of a 20-ampere 115-volt service outlet may be completed before delivery of the switch unit. The factory-tested switch unit is then delivered, the cables are plugged in, and after a few quick func-

Fig. 10. Rear view of switch unit



tional checks, the equipment is placed into service.

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The Mechanization of TWX

E. J. TYBERGHEIN

AT 9 P.M. Eastern Standard Time on August 31, 1962, the largest system-wide cutover in the history of telephony took place. On that date, some 60,000 teletypewriter exchange stations (TWX) in the United States were successfully cut over to dial operation. This paper describes dial TWX service and some of the engineering considerations that made the project the success it was.

The actual cutover was a relatively quiet affair. This was partly because it

was made to coincide with the beginning of a long holiday weekend when TWX traffic was light. The long weekend provided an opportunity to get a feeling of how the new operation would go, and to put into effect a large-scale testing program to ferret out any problems that might have been overlooked.

TWX service was mechanized primarily to improve service to the customer by providing faster and more efficient transmission of written messages between TWX machines. The TWX system handles over 3,000,000 messages per month. The average TWX call covers about 800 miles. Under the previous service which was started in 1931, calls had to be switched manually; often two or more operators were required to handle each call. Such manual handling was not

only costly, but time consuming, since each call required about 2½ minutes to set up. Certainly with the increased need for better data communication, the handling of TWX traffic on a manual basis was an anachronism in this age of automation.

A task force was set up by the American Telephone and Telegraph Company early in 1960 to formulate a plan for mechanizing TWX. Following are three of the task force's objectives:

1. Cut over manual TWX as quickly as possible. In addition to the obvious desirability of modernizing TWX service as quickly as possible, there was considerable urgency to get the program started early enough to avoid the major rearrangements needed at some of the larger manual-switching locations.
2. Provide a station that would be simple for the customer to use.
3. Provide satisfactory transmission and switching performance.

The formal proposal for mechanizing TWX was presented for the operating companies' consideration in May 1960.

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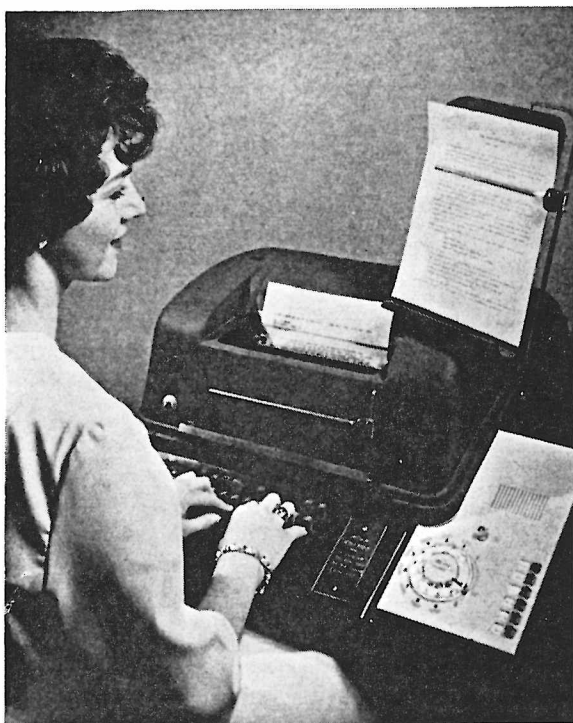


Fig. 1. Dial TWX station consisting of a 28KSR teletypewriter and a 689C attendant set

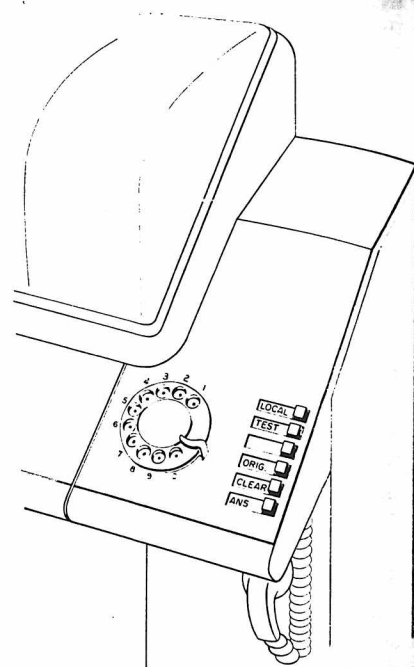


Fig. 2. Close-up view of 689A attendant set

The plan was as follows:

1. All TWX stations would be mechanized on a flash-cutover basis in the fall of 1962.
2. All mechanized TWX stations would be served from regular telephone central offices. They would be assigned regular 10-digit telephone numbers and would complete calls over the Direct Distance Dialing (DDD) network in a manner similar to that for telephone stations. The facilities serving the TWX stations would differ from regular telephone stations in that voice communication to telephone stations or to other TWX stations would not be possible.
3. Assistance, collect, and conference calls would be handled by TWX operators located at 16 operating centers around the country. Information would be handled at the operating center in St. Louis, Mo.
4. Existing teletypewriter machines would be retained.
5. A new data set would be developed to couple the teletypewriter machine to the central office loop.
6. Other items of equipment would be developed as required.

In addition to the data set and switchboard equipment mentioned above, the following equipment was required:

1. An attendant set to permit the customer to dial and supervise the placing of his calls.
2. Service-observing equipment to permit monitoring the new service's performance.
3. Redesign of the 1A line concentrator to permit its use over carrier facilities.
4. Maintenance facilities, including new fixed and portable test equipment for testing the station equipment.

5. Miscellaneous transmission and switching equipment.

Despite the co-ordination and technical problems involved, the first objective of the task force was achieved just over 2 years from the time the plan was first presented. During these 2 years planning and co-ordination had to take place among the operating companies, the independent telephone companies and manufacturers, and the Western Electric Company. Equipment had to be designed, built, and installed, and customers had to be notified and instructed on the use of the new station arrangement.

Station Design

The second objective, which concerned the customer's convenience, was also successfully achieved. First of all, there was no change in the basic teletypewriter machines; that is, the 14-, 15-, 19-, and 28-type teletypewriters have been retained. Fig. 1 shows a 28KSR teletypewriter equipped with the new attendant set. As was the case with manual TWX, both attended and unattended service are offered. Customers subscribing to attended service must be present to accept incoming calls. Those subscribing to unattended service are provided with station equipment that answers automatically when called; no one need be present. An innovation introduced with dial TWX operation was the equipment of all unattended 28-type machines with a multicharacter answer-back unit which op-

erates whenever the station is called. This multicharacter answer-back, which identifies the station, can also be operated by sending the new "Who are you?" (WRU) code to the distant station, or by depressing the "Here is" key on the station itself. All unattended 14, 15, and 19 machines answer with the letter "V," as it was impractical to provide a multicharacter answer-back for them.

Setting up a call from a dial-operated TWX station is simple and direct. (Refer to Fig. 2, which shows the attendant set.) To place a call, it is only necessary to pick up the receiving handset, depress the "ORIG" key, listen for dial tone, and dial the called station's number. As indicated previously, unattended stations answer automatically and either respond with the letter "V" or with the multicharacter answer-back. Attendants at attended stations answer incoming calls by depressing the "ANS" key and then manually typing the station's identification. As in the case for telephone calls, the progress of a call is determined by monitoring the line, using the receive-only handset provided. If a busy or other condition is encountered which prevents the completion of the call, regular call progress tones or announcements will be heard.

To terminate a call, the "CLEAR" key is depressed. Operation of this key causes the station first to send a disconnect signal to the distant end and then to go on-hook. This key also removes any

condition set up by any of the other four keys illustrated in Fig. 2.

To practice on the teletypewriter the "LOCAL" key is depressed. In this mode the station will not answer automatically when called, but the bell will ring, notifying the attendant that someone is trying to reach that station. To answer the call, it is only necessary to depress the "ANS" key.

Operation of the "TEST" key connects the d-c output of the data set to its d-c input. This "loops back" the teletypewriter signals sent to the station from a test location and bypasses the teletypewriter machine.

Method of Serving Dial TWX Stations

Some 900 central offices around the country were selected to serve the dial-operated TWX stations. TWX subscribers are charged for each completed call, therefore, automatic message accounting (AMA) records of all these calls are kept.

Centralized AMA equipment with operator identification of the calling customer cannot be used because voice communication from the station is not possible. Although no. 5 crossbar offices with local AMA are preferred for TWX service, they are not available in all areas serving TWX stations. Consequently, some step-by-step offices equipped with automatic number identification (ANI) and centralized automatic message accounting (CAMA) equipment and some no. 1 Crossbar offices with local AMA or ANI CAMA are used.

The charge per TWX message depends on the distance and duration of a call. Mileage is determined by the distance between the rate-center areas in which the stations are located. In order to minimize message sorting at the accounting centers, it is desirable to assign a different office code for each rate center involved. Where separate codes are not assigned for each rate center, messages must be sorted from TWX stations to these centers by the thousands or possibly even the hundreds digit of the called station's number. There are not yet enough central offices with AMA or ANI plus CAMA located in the right spots around the country to provide all of these rate-center codes. To solve this problem, a divided access line circuit (DALC) was developed. This unit makes it possible for a TWX station to originate messages from one central office (having AMA or ANI CAMA) and receiving incoming messages via a different central office

which has a proper rate-center code. Several typical line and trunking arrangements for serving dial TWX stations are shown in Fig. 3. It will be noted that only voice-band loops are used. Loop plant investments are kept to a minimum by using 1:1 line concentrators. Line concentrators permit serving a relatively large number of stations with few facilities. By use of a separate signaling circuit to interconnect the two concentrator units and special logic circuitry in the units themselves, each local line appearance at the remote unit is associated with a corresponding central office appearance at the control unit. In this way, whenever a station assigned to line 1 for example goes off-hook, it will always appear on line 1 at the central office even though different trunks may be used each time between the concentrator units. In the same way, ringing of any particular line at the central office end will result in ringing the correct station.

Transmission Considerations

TWX is operated over the DDD network by arranging the data set to transmit in the *F2* mode [2,025 to 2,225 cps (cycles per second)] whenever it is called, and in the *F1* mode (1,070 to 1,270 cps) whenever it originates a call. Two bands of frequencies are used for circuit assurance and to send a "break," that is, a stop signal to the sending station. A loss of received signal at either station will cause that station to go on-hook after it sends a disconnect signal to the other station.

Three-row TWX stations operate at 60 words per minute using the Baudot code. The actual bit speed on the line is

only 45 bauds. Because of this relatively low speed and because the frequencies used are near the center of the voice band, delay distortion and cross-band mark-to-space attenuation distortion are not severe problems. The principal transmission problems that affect TWX performance are noise, especially impulse noise, and low received-signal levels that may be encountered on certain limiting calls. There has been a real effort for the past few years to reduce the noise encountered on the DDD network in order to improve performance of Data-phone service as well as regular telephone service. Many improvements have been made along this line; more will be made in the future.

Most TWX calls will encounter only three or four switched links. However, some will encounter many links and, in the limiting condition, a call could encounter nine switched links. Fig. 4 shows a few of the routings that can be encountered over the DDD plant. The large number of switched links by itself would normally cause no problems if it were not for the day-to-day variations of attenuation that facilities experience. To take into account completely these day-to-day variations and the maximum number of links that could be encountered, it would have been desirable to design the TWX data set to have a sensitivity of, for instance, -60 dbm (decibels referred to 1 milliwatt) or lower. Although operating at such a low level would not have added much to the cost of the data set, all noise has not yet been eliminated from the telephone plant. Use of such low levels would have meant that whenever a circuit was lost, there would have

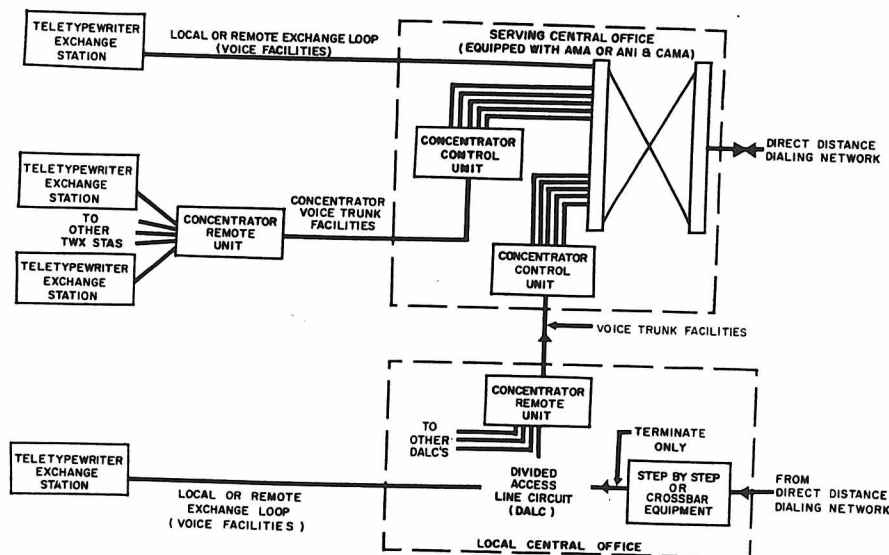


Fig. 3. Typical line and trunking arrangements used to serve dial TWX stations

printed copy of the teletypewriter. After the station is thus checked for its ability to receive, it gets a typed request from the ADTL to transmit. Any distortion in transmission is automatically measured by the ADTL and a "TRAN OK," indicating good transmission, or "OUT-LIN," indicating a fault, is automatically typed back. Fig. 5 shows a sample copy obtained from use of the ADTL.

Performance

All the automatic features of the new system would be of little value to TWX

customers if they did not assure an error performance at least as good as, and preferably better than, that of the present manual system. Field tests conducted jointly by the American Telephone and Telegraph Company, the operating companies, and the Bell Telephone Laboratories indicate that there is a 99% probability of sending a 10-line message without errors due to transmission. Usually an error affects only one character; occasionally one will affect several characters. The rate of errors will vary depending on the facilities over which a call is routed, and the number of links in-

involved. Some customers will have a slightly higher error rate, others lower.

Future Developments

The conversion of TWX to dial operation is a big step forward in providing customers with more efficient means of transmitting data from one point in the United States to another. Much more sophisticated equipment is required for customers with heavy traffic loads. Such equipment is continuously being designed and will be offered as the need actually arises.

A Developmental Line-Switched Teletypewriter Service

Data Set and Systems Considerations

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THE DECADE following the end of World War II saw an unprecedented growth in the number and extent of private-line teletypewriter systems; this was accompanied by technological developments aimed at efficient utilization of intercity lines, speed and security of message delivery, facility of message preparation, and flexibility of operation. The trend was toward increased automation and full employment of the switching techniques which were being developed in the communications industry.

The sophisticated message-switching networks which resulted are now commonplace with many industrial and airline customers; the sustained increase in number and scope attests to the necessity and usefulness of such systems. The 81D1 teletypewriter switching system¹ is of this type, and a brief description of it will illustrate the state of evolution these systems had reached when the present development was undertaken.

An 81D1 system employs a centralized switching center from which numerous

lines serving tributary stations radiate. All traffic is in the form of individual messages received at the center and then automatically routed to the appropriate destinations by means of reperforator transmitters in association with incoming and outgoing line and trunk circuits, directors, sequence circuits, link circuits, etc. It is customary to establish a center at the administrative headquarters of the customer, who provides the building space and primary power. The quantities of teletypewriter and switching equipment involved are determined by studying the existing requirements and expected growth. Full-time assignments of maintenance personnel are usually required and the general outlines of the undertaking become comparable to those of a telephone central office. Although the center is maintained by the telephone company, it constitutes part of the customer's communication activity and is operated by a specifically assigned group of his personnel. Requirements vary, but tape reel changing, redirecting messages with invalid address codes, and general administration of the network constitute an appreciable work load at the center, even with the fully automatic switching features provided.

In contrast, the tributary station must be operated by people who have a number

of other job functions. Therefore, the message format, which must be exact, has been kept simple; address codes have been abbreviated and directory usage kept to a minimum.

By the late 1950's, the growth trends of some of these systems became a source of major concern. In some forecasts, the required size exceeded the maximum design limit of the switching unit; in other predictions, the customer clearly lacked space in which to expand. To alleviate these conditions, the system was rearranged so that the 14-, 15-, and 19-type teletypewriter equipment could be supplanted with the 28 type; this made it possible to increase the speed of operation from 75 to 100 words per minute. Although substantial benefits were provided, a need remained for additional features not readily applicable to the 81D1 system, and it became evident that a more basic and flexible solution was required.

Basis for New Design

Extensive studies undertaken from 1958 to 1959 indicated that there were many advantages to be gained by undertaking the development of a new service based on the following fundamental principles:

1. Utilize the switching capabilities of selected offices of the nationwide telephone switching network.
2. For the efficient use of facilities, interconnect the selected offices by common trunk groups; narrow-band trunks would be adequate for this service.
3. Provide the fully automatic mode of station operation used by private-line systems.
4. Switch all traffic point-to-point.

The implications of these principles are far reaching. Consolidating the switching of data or teletypewriter traffic

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